Development and Evaluation of a Screening Level Flowing Water Exposure Modeling Approach for Endangered Species Assessments

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The US Fish and Wildlife Service and National Marine Fisheries Service (FWS/NMFS) have proposed generic aquatic habitats for which potential pesticide exposure must be determined as part of national endangered species risk assessments (ESA). Three of these generic habitats represent flowing water systems that range from very low flow steams and ditches, to high flow main stem rivers. In their recently released Biological Evaluations (BEs) for three organophosphate (OP) insecticides (chlorpyrifos, malathion, and diazinon), the US EPA concluded that the currently available pesticide exposure modeling tools (PRZM/VVWM) and proposed parameterization approaches are not adequate for representing pesticide exposure in the medium and high flow aquatic habitats defined by FWS/NMFS. The need for scientifically defensible and straightforward to implement models and tools to predict pesticide exposure in flowing water bodies motivated the exploration of alternative models as a replacement for VVWM. Both the Soil and Water Assessment Tool (SWAT) and AGRO-2014 were investigated. The SWAT hourly pesticide routing model was used to represent a single flowing water channel matching the dimensions, flow rate, and velocity of the three FWS/NMFS generic flowing habitats. Improvements were made in the sorbed pesticide fate processes in the SWAT pesticide routing code by linking these pesticide processes to the sediment transport, deposition, and resuspension processes in the model. The PRZM model provided the daily runoff, erosion, soluble, and sorbed pesticide inputs to the SWAT channel model and AGRO-2014. The PRZM model was parameterized following conservative assumptions proposed by EPA for use in ESA modeling, and watershed areas were determined based on hydrologic time of concentration principles constrained to 1-day travel times. Drift inputs were based on AgDRIFT-predicted drift fractions associated with the assumed width of each water flowing water habitat. Exposure scenarios from 10 crop groups and 18 HUC2 watersheds were simulated for two of the three OP insecticides that EPA has focused on in their first round of BEs. PRZM-SWAT and PRZM-AGRO simulations were compared to results from PRZM-VVWM for these same scenarios. Each model had the same PRZM daily input time series, allowing direct comparison of the receiving water model only. These simulations showed that the SWAT and AGRO-2014 resulted in similar annual maximum concentrations for both daily and 21-day average concentrations for the medium and high flow habitats, while the VVWM model had a systematic high bias. Simulation result for the low flow habitat resulted in a significant high bias in VVWM compared to SWAT and a low bias for AGRO-2014 compared to SWAT. The conclusion from this is work is that the SWAT channel routing model can serve to simulate a receiving water in screening level exposure modeling for endangered species, and its predictions are supported by a the AGRO-2014 model, particularly for the medium and high flow aquatic habitats. AGRO-2014 is also a viable model, although improvement in computation time would make it more practical for broad use.

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